

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

VOL. XXIII.

JULY, 1895.

No. 7.

INTRODUCTION.

The REVIEW for July, 1895, is based on reports from about 2,884 stations occupied by regular and voluntary observers. These reports are classified as follows: 148 from Weather Bureau stations; 35 from U. S. Army post surgeons; 2,542 reports from State Weather Service and voluntary observers; 33 from Canadian stations; 96 through the Southern Pacific Railway Company; 30 from U. S. Life-Saving stations; monthly summaries from local services established in all

States and Territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

The WEATHER REVIEW is prepared under the general editorial supervision of Prof. Cleveland Abbe. Unless otherwise specifically noted, the text is written by the Editor, but the statistical tables are furnished by the Division of Records and Meteorological Data, in charge of Mr. A. J. Henry, chief of that division.

CLIMATOLOGY OF THE MONTH.

GENERAL CHARACTERISTICS.

The surface of the United States was generally covered by areas of high pressure, but the weather does not seem to have been warmer or drier than the normal; on the contrary, an unusual number of stations reported the occurrence of abnormally low minima and the deficits of accumulated temperatures continued to increase. The precipitation was deficient in the Lake Region and Ohio Valley. The water in the rivers was unusually low, except in the Red River, and the accumulated percentages of rainfall indicated impending drought. Numerous severe local storms of wind and rain occurred in the upper Mississippi Valley and the western slope of the Rocky Mountain Region.

ATMOSPHERIC PRESSURE.

[In inches and hundredths.]

The distribution of mean atmospheric pressure for the current month reduced to sea level, as shown by mercurial barometers not reduced to standard gravity and as determined from observations taken daily at 8 a. m. and 8 p. m. (seventy-fifth meridian time), is shown by isobars on Chart II. That portion of the reduction to standard gravity that depends on latitude is shown by the numbers printed on the right-hand border.

The mean pressures were highest in the South Atlantic and Gulf States and on the coast of Washington. The highest was 30.12, Key West; 30.11, Tampa, Jupiter and Titusville; 30.10, Fort Canby. The lowest mean pressures were in California, British Columbia, and Canada. The lowest was 29.82, Keeler.

The current departures from the adopted normal pressure for July show an excess in the South Atlantic and southern extremities of the Gulf States, and in Washington, Wyoming, and Nebraska. The greatest excess was Key West, 0.06. Pressure was deficient in a belt extending from southwestern Texas through northern Louisiana, Mississippi, Alabama, Georgia, South and North Carolina to Cape Henry, and in small regions on the Atlantic Coast from Nantucket to Atlantic City, at Fresno, and Yuma. The greatest deficit was Nantucket, 0.04.

As compared with the preceding month of June, the pressures reduced to sea level show a rise only in southern Florida, at Corpus Christi, and in a small region from El Paso to Pueblo. The maximum rise was Key West and Jupiter, 0.03. Throughout the rest of the country pressure fell. The maximum falls were: Sydney, Charlottetown, and Chatham, 0.16.

The systematic periodic diurnal variations of pressure are shown by the hourly means given in Table V.

HIGH AND LOW AREAS.

[By Prof. FRANK H. BIGELOW.]

The tracks of ten areas of high pressure, including the subdivision of Number IV, are plotted on Chart IV for the month of July. An inspection of the map shows that these originated or tended to linger in four distinct localities, viz: The North Pacific Coast, the South Atlantic Coast, the Lake Region, and the middle Rocky Mountain Slope, the latter being a place of dissipation of the highs. Thus, the water surfaces under the general high belt of middle latitudes, where it impinges upon the continent, were the places for highs to persist for many days in summer. The continuity of this belt is broken by the heated lands of the middle parts of the continent. The cooling of the air near the Lakes was also favorable for highs to form and to retain their position in that place during the current month.

The tracks of eleven areas of low pressure are plotted on Chart I. They prevail for the most part in the neighborhood of the northern circuit, or between the parallels 40° to 50°. The Rocky Mountain Slope, as far south as Kansas, was in some cases the source of a storm, and in a few others the place where they dissipated. The South Atlantic and the Gulf States appear not to have been visited by a distinct storm of any description.

HIGH AREAS.

I.—The month opened with a high area covering the Lake Region, with a relatively high barometer in the Mississippi Valley and over the South Atlantic States. Rain fell very generally in the Middle Atlantic States, the Ohio Valley, and

the Gulf States, during the 1st, with a few thunderstorms. On the 2d the high moved slowly eastward and became central over Lower Michigan. At the same time the rain areas passed to the coast line in the neighborhood of the Carolinas. The center of the high was formed on the 3d near Lake Erie, the high pressure covering all of the districts east of the Mississippi River, and with precipitation in southwestern portions over the lower Mississippi Valley. On the 4th the high retained nearly the same position, but the rain area extended northwestward up the Mississippi Valley. Another rain area formed over the North Atlantic Coast and the New England States. During the 5th the high moved rapidly northeastward, covering New England, central near the Bay of Fundy, the rain with thunderstorms continuing in New England, especially near the coast line. The temperature conditions were nearly stationary during these five days, except on the 4th, when there was a fall on the Middle Atlantic Coast caused by the movement of this high.

II.—A feeble area of high pressure occurring on the 1st over the South Atlantic States, and probably as a portion of I. It was active in causing the rains that fell in the Southern States.

III.—Also a feeble high in the same region during the 3d and 4th, showing very little movement, and doubtless a portion of the Atlantic area intruding upon the continent.

IV.—On the 5th a high area appeared on the Middle Pacific Coast, which passed to Oregon and Washington during the 6th and 7th, crossed the Mountains to South Dakota by the 8th, advanced to Kansas on the 9th, where it divided. The branch—

IVa.—Moved westward and covered Kansas during the 10th, 11th, and 12th, where it dissipated in western Nebraska; the other branch, IVb moved rapidly eastward to the Virginia coast, where it held during the 11th and 12th before breaking up. The progress of this area over the northern Rocky Mountain Slope seems to have been favorable to the production of showers in the Missouri Valley, which fell during the 7th and 8th. The break-up or division on the 10th was conducive to rain in the Southwestern States. This rainfall moved gradually eastward over the Gulf States and continued till the 12th in scattered localities, while the high held its place on the Atlantic Coast. A fall of temperature attended this high in the Missouri and Mississippi valleys on the 8th, the Lake Region and the Ohio Valley on the 9th, and the Atlantic districts on the 10th.

V.—This was a small area of high pressure on the South Atlantic Coast during the 12th and 13th; it occasioned some rain and thunderstorms in the eastern Gulf States at that time.

VI.—This area began to assert itself on the North Pacific Coast during the 14th, lingered in that region with some very uncertain movements till the 20th, when it rapidly passed over the middle plateau and slope to Colorado, where it disappeared on the afternoon of the 20th. It is a good example of the influence of the ocean in forming and maintaining a high in this position for at least 6 days, yet it was unaccompanied by any weather characteristics till the 20th, when by its eastward movement it caused thunderstorms and rain generally in the lower Missouri Valley on the 19th, and further eastward, especially in the middle Mississippi and Ohio valleys on the 20th, the list of local storms being very long on that date. There was a marked rise in temperature over the Plateau on the 14th, but otherwise the temperature ranges were not noteworthy.

VII.—This was an eastern area of high pressure at first central over the lower Lakes, but covering the Atlantic States generally during the period from the 18th to the 24th. On the 19th the center moved to the coast near New Jersey, and thence proceeded southward, reaching Carolina by the 20th,

and Florida by the 21st, where it held until the 24th, forming a part of the usual Atlantic high. Showers and local storms occurred in the Gulf States on the 22d, 23d, 24th, 25th. The effect of this high was to cause quite continuous precipitation along its northern border. It is on the whole to be remarked that many of the summer rains occur in the midst of or on the borders of the highs, this condition being really as favorable to the production of precipitation as the low areas to which rain is ordinarily attributed.

VIII.—Formed during the 20th on the North Pacific Coast. Moved rapidly eastward over the northern boundary to the Dakotas on the 21st, causing a few showers in North Dakota. On the 22d it passed southward along the mountain slope to Nebraska, the cooler air producing precipitation in the lower Missouri Valley, and generally over the Gulf States. During the 23d and 24th it lingered over Iowa and Kansas, the rain area at the same time extending to the Carolina coast in the neighborhood of the thirty-fifth and fortieth parallels. By the afternoon of the 25th the center of the high reached the Gulf coast in eastern Texas and dissipated in the Gulf States during the 26th, causing some heavy rains in the Carolinas.

IX.—On the 27th a high formed to the northwest of the Lakes and moved rapidly south to Indiana on the 28th, when it spread out and dissipated over the eastern districts. Its advance caused general showery conditions with thunderstorms in the lower Lake Region and the Ohio Valley. There was a decided fall of temperature in the upper Ohio Valley on the 27th.

X.—Formed on the mountain slope to the north of Montana on the morning of the 29th, moved southeastward to Lake Superior on the 30th, and then remained stationary in eastern Minnesota on the 31st, being central near La Crosse at the end of the month. Showery conditions began in the upper Mississippi Valley on the 29th, and extended over the Ohio Valley on the 30th, and even to the South Atlantic States by the evening of that day, the precipitation ceasing for the most part on the 31st. On the 30th the temperature fall was decided over the Lakes, and the cooler weather covered the Middle States and New England during the 31st.

AREAS OF LOW PRESSURE.

I.—Appeared on the Rocky Mountain Slope north of Montana on the 1st, lingered in the north Montana region during the 2d, 3d, and 4th, with very little movement, but on the 5th it passed over the Dakotas to Kansas, where it disappeared on the 6th. There were no important features developed, and the precipitation was very light near the central portions of the storm.

II.—Began on the 6th in North Dakota, moved directly eastward in the usual track, crossing the Lakes on the 7th and 8th, then passed down the Saint Lawrence Valley and disappeared near Nova Scotia during the 10th. On the 6th there was quite a large precipitation in North Dakota, and to the northwestward, in the rear of the storm, and this followed to the Lakes, but in passing the Lakes on the 8th the rain area changed to the southeast quadrant and advanced before the center. This shift of the area of rain relatively to the center, from being to the northwest of it in the Dakota region to being southeast of it in the Ohio Valley, is a very commonly observed feature of the northern storms in winter as well as in summer. It argues decidedly against the opinion sometimes urged that the storm moves to the region of greatest rainfall. This latter view may be one more case of the substitution of an effect produced by many causes for the real cause of storm movement.

III.—This storm followed precisely the same course as II, originating in the Saskatchewan Valley on the 10th, and moving over the Lakes on the 11th and 12th to Maine, where it dissipated on the 14th. The precipitation was very light

even near the center till it reached New England, when a marked group of thunderstorms took place during the afternoon of the 13th in the southwestern quadrant.

IV.—Pursued a very regular track from the Pacific to the Atlantic Coast in the northern circuit. It originated in Oregon on the 11th, passed up the Columbia River Valley on the 11th and 12th, and down the Saskatchewan Valley on the 13th and 14th, thence over the Lakes on the 15th and 16th, the Saint Lawrence River on the 17th and 18th, to Nova Scotia on the 19th, where it disappeared as a distinct center. The storm remained dry till the 14th, when local storms occurred in the Mississippi Valley, and then advanced to the south and east of it giving general showers in the Ohio Valley and the Atlantic States on the 15th and 16th, while the center was in the upper Lake Region, after which the precipitation advanced to New England, while the center was in the lower Lake Region on the 17th, the weather being clear during the movement of the center to the coast line.

V.—This was one of short durations beginning in Utah on the 17th, moving eastward over South Dakota, thence south to Kansas on the 18th, and dying out in Illinois on the 19th. Its progress did not sensibly influence the temperature and precipitation.

VI.—Moved from Utah on the 19th to the Gulf of St. Lawrence on the 24th, passing South Dakota and Iowa on the 20th, the Lake Region on the 21st, New England on the 22d, where, after some delay in the interior, it finally moved to Newfoundland. On the 20th a series of local storms covered the middle Mississippi and Ohio valleys; on the 21st the precipitation took place in the Middle States, and on the 22d in New England.

VII.—Moved quite rapidly from the one hundred and twentieth meridian north of Montana on the 23d to the Gulf of St. Lawrence on the 29th, crossing Montana on the 25th, the Dakotas on the 26th to western Iowa, the States of Illinois, Indiana, Ohio, and New York on the 27th, passing the New England Coast on the 28th to Nova Scotia, near whose northern extremity it disappeared. When the center was in Iowa showers began in the Ohio Valley on the 26th, which covered the lower Lake Region and the Middle States on the 27th, and New England on the 28th.

VIII.—Appeared in the upper St. Lawrence Valley on the 24th, passed down the river, thence turned abruptly south to Maine, and finally reached the Gulf of St. Lawrence on the 26th.

IX.—Formed on the northern Plateau near Washington on the 26th, moved to west Dakota on the 27th, near which place it delayed a day, passed over Nebraska and Kansas on the 29th, and to Oklahoma on the 30th, where it disappeared. In its course it followed closely the eastern edge of the high ground of the Plateau. It presented no noteworthy features.

X.—First formed near Lake Huron on the 29th, moved eastward to northern New England on the 30th, and thence northward to the lower St. Lawrence Valley, where it was at the end of the month. On the 30th extensive local storms covered New England and the Middle Atlantic States.

XI.—This low occupied the extreme northwestern districts to the north of Montana on the 29th, 30th, and 31st, without any special movements, being accompanied by very little precipitation.

MOVEMENT OF CENTERS.

The following table shows the date and location of the center for the beginning and ending of each area of high or low pressure that has appeared on the U. S. weather maps during the month, together with the average daily and hourly velocities. The monthly averages are computed in two ways; first, by considering each path as a unit, and second, by giving equal weight to each day of observation:

Movement of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.										
I.....	1, a. m.	49	86	5, p. m.	45	66	1,600	4.5	355	14.6
II.....	1, a. m.	30	85	1, p. m.	28	82	260	0.5	520	21.6
III.....	3, a. m.	30	81	4, p. m.	31	81	370	1.5	247	10.3
IV.....	5, a. m.	41	124	12, p. m.	40	102	3,230	7.5	431	17.9
V.....	10, a. m.	39	94	12, a. m.	39	74	1,070	2.0	535	22.2
VI.....	12, p. m.	35	77	13, p. m.	31	83	540	1.0	540	22.4
VII.....	14, a. m.	45	124	20, p. m.	39	104	2,310	6.5	355	14.7
VIII.....	18, a. m.	45	86	24, a. m.	26	80	2,020	6.0	397	14.0
IX.....	20, p. m.	50	124	25, p. m.	30	94	3,520	5.0	704	29.3
X.....	27, a. m.	49	96	28, a. m.	41	86	740	1.0	740	30.7
XI.....	29, a. m.	50	106	31, p. m.	44	92	1,010	2.5	404	16.8
Sums.....							16,670	38.0	5,168
Mean of 11 paths.....									470	19.5
Mean of 38 days.....									431	17.9
Low areas.										
I.....	1, a. m.	53	108	6, a. m.	38	99	1,900	5.0	380	15.8
II.....	6, a. m.	50	108	10, a. m.	45	64	2,090	4.0	520	21.6
III.....	10, p. m.	53	104	14, a. m.	45	69	1,750	3.5	500	20.8
IV.....	11, a. m.	44	123	19, a. m.	46	80	3,500	8.0	438	18.2
V.....	17, a. m.	40	112	19, a. m.	41	88	1,680	2.0	845	35.1
VI.....	19, a. m.	39	112	24, a. m.	47	60	3,040	5.0	608	25.3
VII.....	39, p. m.	51	120	20, a. m.	48	61	3,800	5.5	691	28.7
VIII.....	24, p. m.	46	75	26, a. m.	48	64	890	1.5	593	24.6
IX.....	36, p. m.	51	115	30, a. m.	36	97	1,860	3.5	531	22.0
X.....	29, a. m.	47	83	31, p. m.	49	71	800	2.5	320	13.3
XI.....	29, p. m.	51	116	31, p. m.	51	107	570	2.0	285	11.9
Sums.....							21,880	42.5	5,711
Mean of 11 paths.....									519	21.6
Mean of 42.5 days.....									515	21.4

LOCAL STORMS.

[By Mr. A. J. HENRY.]

During the period between July 3 and July 8, the eastern slope of the Rocky Mountains from central Kansas to the Lakes, and southerly from Iowa to central Texas, was visited by storms that caused great loss of human life in two or more localities, and wide-spread and enormous destruction of property. Railroad embankments and bridges were washed away, farms and villages flooded, and at two points violent winds added their destructive powers, killing and maiming, and also tearing buildings to pieces.

The casualties approached 100, including over forty deaths. Conservative estimates place the loss of property during the four days at more than a million dollars. Growing crops were at their best, the wheat harvest had begun, and the season had so far passed as to preclude reseeding.

Isolated thunderstorms occurred in Colorado, Kansas, Arkansas, Louisiana, Mississippi, and northern Texas, as early as the 2d. On the 3d the rain and thunderstorm area extended as a broad belt from western Kansas southeasterly to western Georgia and Florida. On the 4th the weather had cleared in western Kansas, but otherwise the same conditions prevailed as on the previous day.

The rainfall was general over Missouri and southeastern Kansas, Indian Territory, and northern Arkansas. The fall at Birch Tree, in southern Missouri, is given at 6 inches; at Fort Scott, Kans., 4.19; at Beloit, Kans., 6; at Topeka, Kans., from 8 o'clock p. m. to midnight, 3.02.

On the afternoon of the 5th a tornado swept over Baxter Springs, Kans., followed by a deluge of rain. Five persons were killed outright, and more than double that number were injured, some fatally; churches, schoolhouses, business structures, dwellings, and barns, with the contents of all, were destroyed.

On the same evening a cloudburst brought death and desolation to Winona, Mo. Rain began falling about 10 o'clock, and an hour later a small stream passing through the town had become a raging torrent that submerged the village near its

banks to a depth of four feet. Twelve were drowned and many others received severe injuries. Only the lightning flashes enabled the frightened inhabitants to partly see and avoid the dangers that surrounded them. Buildings standing on high ground or in the outskirts of the town alone escaped. Loss of life and property from violent storms on the same date occurred in other towns in Missouri, Kansas, and Arkansas.

On the 7th rain was reported from central Kansas to the Ohio River and southeasterly to Florida, and was quite generally accompanied by winds of great velocity. In Putnam and Morgan counties, Ga., several lives were lost and many injuries sustained. In many localities within the States of Tennessee, Texas, Missouri, and Kansas, wind and rain destroyed crops, fruit trees, and small buildings, inflicting large damage in the aggregate, although serious local disaster was not sustained.

About 6 p. m. of this date Chicago was visited by a furious storm of wind and rain. One man was drowned by the upsetting of a boat in the Lake, where the wind imperiled many craft. Several persons were injured by flying timber and glass, many large plate windows being hurled through the air. On Lake Geneva, Wis., a steam launch was swamped and the six occupants drowned.

From the 9th to the 13th no destructive storms were reported. On the afternoon of the 13th a tornado swept over the country in the vicinity of the City of New York. Fatalities occurred at Woodhaven, L. I., and Cherry Hill, N. J. The last-named town was practically demolished; three persons were killed and many more were hurt; 25 families were left homeless, and other losses of property resulted.

At Woodhaven one person was killed, nearly thirty were injured, and a large amount of property was destroyed. In these cases the devastation was wrought in the space of but a few minutes. The wind was preceded by hail, and thunder and lightning accompanied the violent rainfall. Damages to growing crops during these storms were reported in the southern parts of Massachusetts and Connecticut.

On the night of the 16th and morning of the 17th a severe rain and windstorm did large damage in central Illinois. It was the most disastrous within many years at Peoria, Bloomington, and Dixon, Ill., and extended into Indiana and Missouri.

Late on the 18th and early on the 19th, heavy rainfall occurred in Iowa, Minnesota, Kansas, and Illinois. Precipitation was unusually heavy at St. Paul and Winona, Minn.; Iowa City and Iowa Falls, Iowa; Paris, Trenton, and Marshall, Mo.; and Pekin and Peoria, Ill. Wind was destructive at Pekin, and serious damage resulted from overflowing streams in Iowa. Storms of unusual severity, though of circumscribed area, were reported in southeastern Wisconsin and eastern Kansas.

On the afternoon of the 19th rain, succeeded by hail and terrific winds, wrought losses in the Ohio oil fields near Findlay, amounting to \$500,000 within the town, and injured property in the surrounding country to about the same extent. The city of St. Clair, Mich., was visited by a storm of like character, and but little less violence, about the same hour. One death was caused and damages to property estimated at \$15,000. Heavy rain, with thunder and lightning, all of unusual violence, were reported from various towns in Indiana, Iowa, Illinois, and Tennessee.

On the afternoon of the 20th the eastern suburbs of Baltimore and the adjoining county were swept by wind of 70 miles an hour. Buildings were destroyed and one child was killed. The track was about 600 yards wide. A blinding rain accompanied the wind. A tornado on the same day destroyed property in the counties of Sullivan, Ulster, and Orange, N. Y.; New York City was also touched. In Ottertail County, Minn., on the same afternoon, buildings were

destroyed, injuries, supposed to be fatal, sustained, and large losses visited upon growing grain and farm property.

On the afternoon of the 22d the newspapers reported 5 inches of rain as having fallen at Silver City, N. Mex., and that a large portion of the town had been carried away by the flood. Similar storms, of lesser though destructive energy, occurred on the same day at various localities in Illinois, Kentucky, Ohio, Indiana, and Pennsylvania. In Hamilton County, Ohio, a destructive wind attended the rain, unroofing buildings and tearing up trees. Farm animals were drowned, and deaths from lightning were reported. In central Pennsylvania the flood of rain inundated farms and in the coke regions the losses were enormous, involving coke ovens, bridges, railroads, and highways.

On the 25th a tornado struck the town of Baird, near Fort Worth, Tex., killing one man and wrecking several buildings. On the same day hail did damage to the extent of several hundred dollars in central New York and near Marshalltown, Iowa.

Disastrous storms occurred on the 26th and 27th in North Dakota, eastern Missouri, Iowa, Illinois, and Indiana. On the 26th hail in four counties destroyed many thousand acres of wheat, and a tornado followed, killing one man and adding largely to the loss of property. The storm track was estimated at 200 miles in length, and, at places, 4 in width. At Kewanee, Henry County, Ill., a terrific thunderstorm, attended by wind of great violence, left marks upon nearly every house in the town. Several buildings were unroofed and otherwise seriously damaged, leaving the contents at the mercy of the drenching rain.

The counties of Bureau, Peoria, Marshall, Woodford, and Whiteside, Illinois, sustained severe losses from the same storm, the agencies being wind, rain, and lightning.

On the 27th very nearly 2.50 inches of rain fell within four hours at St. Louis. A wind of great velocity prevailed for about two hours at various points in central Ohio and Indiana. Buildings were injured, growing crops destroyed, and farm animals killed.

On the 29th storms of unusual severity occurred at points in Oklahoma, Colorado, Kansas, Iowa, and Missouri.

One of the heaviest rains recorded at Denver was on the 30th, when 0.9 inch fell within twenty-five minutes. Streets were flooded, horse cars stopped, and lightning did damage reckoned at \$5,000.

On the 31st Socorro, N. Mex., was overwhelmed by water pouring from a cloud-burst on the mountain side above the city. Six lives were lost, and the losses in and near the town were estimated at more than \$100,000. A similar disaster, from the same cause, was reported on that date from Casper, Wyo.; two persons were drowned, but the damage to property was less than at Socorro.

TEMPERATURE OF THE AIR.

[In degrees Fahrenheit.]

The mean temperature is given for each station in Table II, for voluntary observers, but both the mean temperatures and the departures from the normal are given for the current month for the regular stations of the Weather Bureau in Table I.

The *monthly mean temperature* published in Table I, for the regular stations of the Weather Bureau, is the simple mean of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to Table II.

The *distribution* of the monthly mean temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart II; the lines are drawn over the high irregular surface of the Rocky Mountain Plateau, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the